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(54) MOLD FOR FORMING PRECISION OPTICAL GLASS ELEMENT AND PRODUCTION OF THE MOLD

(57)Abstract:

PURPOSE: To obtain a forming mold having high durability in a high accuracy by bonding a thin film having inverted form of a precision optical element to the surface of a mold matrix and forming a specific alloy film as a protective layer on the whole mold surface.

CONSTITUTION: A thin film 12 is formed on the surface of a precision optical element master plate 11 processed beforehand in a high precision, the surface of the thin film 12 is polished to a plane as shown in the figure (c) and the film is carefully peeled off from the master plate 11 to obtain a replica of the surface. An Si or SiO2 thin film 13 is formed on the polished surface of the thin film 12. Similarly, an Si or SiO2 thin film 13 is formed on a polished surface of a mold matrix 14 made of e.g. a cemented carbide composed mainly of WC or a thermet composed mainly of TiC or TiN. These Si or SiO2 thin films 13 are hydrophilicized, both faces are brought into contact with each other and the laminate is heat-treated to bond the mold matrix 14 with the thin film 12 having replica surface of the master plate. A thin film of a platinum group alloy such as Ir-Ru-

Ta is formed on the whole surface of the mold as a protecting layer 15 to obtain a forming mold.

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CLAIMS

[Claim(s)]
[Claim 1] Form a thin film in the front face of the detailed optical element original recording processed with high precision beforehand, and this thin film that copied the reversal configuration of a detailed optical element is exfoliated in a precision from detailed optical element original recording. The thing in which the thin film which consists of silicon (Si) or a silicon dioxide (SiO2) was formed at the rear face of this thin film, The thing in which the thin film which consists of Si or SiO2 was formed on the front face of the mold base material which consists of the cermet or WC sintered compact which uses as a principal component the cemented carbide, the titanium carbide (TiC), or titanium night RAIDO (TiN) which uses the tungsten carbide (WC) as a principal component similarly is joined. In the whole mold, platinum (Pt), a rhodium (Rh), iridium (Ir), a ruthenium (Ru), The molding die of the detailed optical-glass component characterized by forming the alloy film contained at least one or more kinds as a protective layer, and being constituted out of an osmium (Os), a tungsten (W), palladium (Pd), a rhenium (Re), and a tantalum (Ta).
[Claim 2] What formed the thin film in the front face of the detailed optical element original recording processed with high precision beforehand, and formed the thin film which exfoliates in a precision and becomes the rear face of this thin film from Si or SiO2 from detailed optical element original recording about this thin film that copied the reversal configuration of a detailed optical element, Although the thin film which consists of Si or SiO2 was formed in the front face of the mold base material which consists of the cermet or WC sintered compact which uses as a principal component the cemented carbide which uses WC as a principal component similarly, TiC, or TiN The manufacture approach of the molding die of the detailed optical-glass component characterized by forming the alloy film which joins both sides and is contained at least one or more kinds in the whole mold out of Pt, Rh, Ir, Ru, Os, W, Pd, Re, and Ta as a protective layer, and manufacturing it after giving each a hydrophilic property.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a molding die required in order to manufacture the glass detailed optical element which was extremely excellent in endurance and which has a highly precise configuration by press forming.
[0002]
[Description of the Prior Art] In order to have produced the highly precise detailed optical element conventionally, the approach of processing resin directly, and the approach by shaping were adopted from the ease of the processing (for example, JP,54-110857,A, JP,60-25761,B).
[0003] However, in order that, as for such a detailed optical element made of resin, a lifting and a configuration may change [resin] a volume change with change of environments, such as temperature and humidity, it has the fault that the precision of a detailed optical element worsens. Furthermore, since the reinforcement of resin is low, there is also a fault that a blemish tends to go into a front face, and the detailed optical element with very highly precise high dependability is not obtained in the product made of resin.
[0004] On the other hand, a glass detailed optical element has good endurance, a blemish cannot go into a front face easily, and precision is not spoiled to an environmental change. Then, the method of processing glass into a detailed optical element configuration by direct dry etching is proposed as the production approach of a glass detailed optical element (for example, JP,55-57807,A).
[0005] Although the method of processing glass by dry etching can mince a detailed optical element configuration directly on a glass front face, it requires time amount for producing one detailed optical element very much, and has the fault that the thing of the same configuration is unproducible in large quantities. Therefore, by the old approach, a glass detailed optical element with very highly precise high dependability was not able to be fertilized.
[0006] On the other hand, recently, the approach of carrying out press forming of the glass is proposed as the mass-production approach of an optical-glass component (for example, aspheric surface glass lens). Image formation quality good for carrying out pressing of the highly precise optical-glass component by this approach, and manufacturing is required.
[0007] For this reason, it is required to be inactive chemically to glass, for the part used as the shaping side of glass to be hard enough, to be hard to receive the damage on an abrasion etc., and for a shaping side to cause neither plastic deformation nor grain growth with shaping in an elevated temperature, but for thermal shock resistance to be excellent also in high temperature as a metal mold ingredient, so that repeat shaping can be performed, and to excel in workability further, so that ultra-precision machining can be performed.
[0008] It considers as the metal mold ingredient with which it is satisfied of these requirements to some extent, and SiC or Si3N4 is reported (for example, JP,52-45613,A). Moreover, the metal mold which coated the platinum group alloy thin film with recently on the cemented carbide base material is also proposed (for example, JP,60-246230,A).

[0009] When SiC or Si3N4 was used for a metal mold ingredient, these ingredients were very difficult to process it into the molding die of a desired detailed optical element configuration, since the degree of hardness is very high, since each of these ingredients was rich in reactivity with glass at the elevated temperature, when repeat press forming was performed further, glass adhered to metal mold and there was a fault of it becoming impossible to fabricate a highly precise detailed optical-glass component.
[0010] Moreover, although the grinding process was possible for the metal mold which coated the platinum group alloy thin film on the cemented carbide base material, there was a fault that a detailed configuration was not processible with high precision. Furthermore, there was a fault that processing it very with high precision took time amount very much.
[0011] Therefore, production of the molding die of a detailed optical-glass component with the sufficient endurance which repeats and carries out press forming of the glass until now, and can mass-produce a detailed optical-glass component was not completed.
[0012]
[Problem(s) to be Solved by the Invention] If press forming of the glass is repeated and carried out and a glass detailed optical element is produced, fertilization of a detailed optical element with very highly precise high dependability is possible. For that, endurance is very good at high intensity, and the press molding die of a highly precise glass detailed optical element is required. However, by the conventional metal mold production approach, the metal mold for detailed optical elements was unproducible.
[0013] It aims at fertilizing a glass detailed optical element with very highly precise high dependability by offering the approach of producing easily the very highly precise metal mold for glass detailed optical elements with sufficient endurance which can repeat and carry out press forming of the glass in this invention, and carrying out press forming of the glass using this metal mold, in order to conquer the above fault.
[0014]
[Means for Solving the Problem] This invention offers the approach of producing easily the molding die of the glass detailed optical element which can repeat and carry out press forming of the glass, in order to solve this technical problem. Namely, a thin film is formed in the front face of the detailed optical element original recording processed with high precision beforehand. The thing in which the thin film which exfoliates in a precision and becomes the rear face of this thin film from Si or SiO2 from detailed optical element original recording about this thin film that copied the reversal configuration of a detailed optical element was formed, Although the thin film which consists of Si or SiO2 was formed in the front face of the mold base material which consists of the cermet or WC sintered compact which uses as a principal component the cemented carbide which uses WC as a principal component similarly, TiC, or TiN After giving each a hydrophilic property, both sides are joined and the approach of forming the alloy film contained at least one or more kinds in the whole mold out of Pt, Rh, Ir, Ru, Os, W, Pd, Re, and Ta as a protective layer, and manufacturing the molding die of a detailed optical-glass component is offered.
[0015]
[Function] According to the approach of this invention, it made it possible to produce easily the molding die of the very highly precise detailed optical-glass component which can carry out press forming of the repeat glass with very sufficient endurance which was not able to be produced until now.
[0016] The metal mold of this invention moreover, by using for a mold base material the cermet or WC sintered compact which uses as a principal component the cemented carbide which uses WC as a principal component, TiC, or TiN Give only the reinforcement which is equal to press forming to the whole metal mold, and a thin film is formed in the front face of the detailed optical element original recording processed with high precision beforehand. The thing in which the thin film which exfoliates in a precision and becomes the rear face of this thin film from Si or SiO2 from detailed optical element original recording about this thin film that copied the reversal configuration of an optical element was formed, Although the thin film which consists of Si or SiO2 was similarly formed in the front face of a mold base material, after giving each a hydrophilic property, by joining both sides By being able to obtain the metal mold which has the reversal configuration of a detailed optical element easily, and

forming the alloy film contained at least one or more kinds in the whole mold out of Pt, Rh, Ir, Ru, Os, W, Pd, Re, and Ta as a protective layer Even if it fabricates glass, glass does not weld to metal mold, but it can be made to carry out press forming of the repeat glass. Therefore, it becomes possible by carrying out press forming of the glass using the metal mold of this invention for repeatability to be good and to mass-produce a glass detailed optical element with the same configuration as detailed optical element original recording.

[0017]

[Example] Hereafter, an example is stated to a detail. first -- as an example of a detailed optical-glass component -- press forming of a glass diffraction grating -- public funds -- the production approach of a mold is explained using a drawing.

[0018] Drawing 1 is drawing having shown the process of the production approach of the press molding die of a glass diffraction grating. The diffraction-grating original recording 11 formed aluminum (aluminum) with vacuum deposition to the disk glass substrate with a diameter [of 20mm], and a thickness of 2mm, and the pitch used what used the roux ring engine for 2 micrometers and a serrate diffraction-grating configuration with a depth of 0.5 micrometers, and was processed into the precision.

[0019] Next, as shown in drawing 1 (b), the nickel-tungsten (nickel-W) alloy thin film 12 was formed in the front face of this diffraction-grating original recording 11 by the thickness of about 15 micrometers by the sputtering method.

[0020] Thus, as shown in this drawing (c), after grinding the front face of the formed nickel-W alloy thin film 12 at a flat surface, the nickel-W alloy thin film 12 is exfoliated from the diffraction-grating original recording 11, and the reversal configuration of diffraction-grating original recording was copied to the nickel-W alloy thin film 12.

[0021] Next, as shown in this drawing (d), the Si thin film 13 was formed in the front face ground at the flat surface of this nickel-W alloy thin film 12 by the thickness of about 1 micrometer by the sputtering method. Similarly, the Si thin film 13 was formed also in the diameter of 20mm and the front face which ground the top-face part of the cermet cylinder which uses TiN with a thickness of 6mm as a principal component to the mirror plane used as a metal mold base material 14 by the thickness of about 1 micrometer by the sputtering method.

[0022] Then, as shown in this drawing (e), the hydrophilic property was given to these Si thin films 13, heat treatment was performed for both sides at lamination and 1000 degrees C for 2 hours, and the nickel-W alloy thin film 12 which copied the reversal configuration of diffraction-grating original recording was joined to the metal mold base material 14 through the Si thin film 13.

[0023] When press forming of the glass is carried out with the metal mold of this condition, the front face of a nickel-W alloy thin film oxidizes, and it becomes impossible to produce a highly precise diffraction grating. Then, as shown in this drawing (f), the iridium-ruthenium-tantalum (Ir-Ru-Ta) alloy thin film was formed in the front face as a protective layer 15 by the thickness of about 5 micrometers by the sputtering method.

[0024] The press molding die of a highly precise glass diffraction grating was able to be obtained easily as mentioned above. Thus, since the press molding die of the obtained diffraction grating copies the configuration of diffraction-grating original recording as it is, if press forming of the glass is carried out using this metal mold, a glass diffraction grating with the same highly precise configuration as diffraction-grating original recording will be obtained.

[0025] Next, press forming of the glass is carried out using the press molding die of this diffraction grating, and the example which produces a glass diffraction grating is explained using a drawing.

[0026] The schematic diagram of the press-forming machine used for drawing 2 by this example was shown. in drawing 2 -- 21 -- the fixed block for punches, and 22 -- the heating heater for punches, and 23 -- a punch and 24 -- a glass plate and 25 -- female mold and 26 -- the heating heater for female mold, and 27 -- a plunger and 211 cover the thermocouple for female mold, and 210, a stopper and 213 cover a positioning sensor and 212, and the fixed block for female mold and 28 come out of the thermocouple for punches, and 29.

[0027] press forming of the diffraction grating produced by the above-mentioned approach -- public

funds -- the mold was made into the punch 23 and the flat-surface metal mold which formed the Ir-Ru-Ta alloy thin film in the front face of the base material which ground the flat-surface part of the upper and lower sides of the cermet cylinder which uses TiN with a diameter [of 20mm] and a thickness of 6mm as a principal component to the mirror plane as a protective layer by the thickness of about 5 micrometers by the sputtering method was used for female mold 25.

[0028] The SF-8 monotonous glass 24 processed with a radius [of 10mm] and a thickness of 1mm in the shape of a disk type is placed on this female mold 25. Place a punch 23 on it, carry out a temperature up to 500 degrees C as it is, hold a pressure for 2 minutes by about 40kg/cm2 press ** by nitrogen-gas-atmosphere mind, and it cools to 400 degrees C in the condition as it is after that. The fabricated glass plate is taken out and the press-forming process of a glass diffraction grating is completed.

[0029] The above process was repeated, the up-and-down metal mold 23 and 25 was removed from the making machine at the time of the 10000th press termination, the condition of a press side was observed with the optical microscope, the surface roughness at that time (an rms value, **) was measured to coincidence, and each mold precision was evaluated to it. Since the highly precise diffraction-grating configuration shown in this example with the conventional metal mold ingredient was not processible, the monotonous metal mold which formed the Pt-Ir alloy film in the cemented carbide base material which uses as a principal component the monotonous metal mold of the SiC sintered compact currently conventionally used as comparative experiments and WC was produced, press forming was performed 10000 times similarly, and mold precision was evaluated.

[0030] The result of a press trial is shown in (Table 1).

[0031]

[Table 1]

試料 No.	金型構成	プレス前の表面粗さ（rms値、Å）	10000回プレス後の表面状態 表面粗さ（Å）	表面状態
1	本発明の金型	上型 9．2 下型 9．1	9．2 9．4	良好 良好
2	SiC焼結体金型	上型 12．2 下型 11．8	測定不能 測定不能	ガラス付着 ガラス付着
3	WC母材にPt-Irを形成した型	上型 9．5 下型 9．2	9．8 9．5	良好 良好

[0032] Glass adhered to the front face and it became impossible for the flat-surface metal mold produced with the SiC sintered compact of sample No.2 to press glass for the metal mold of both upper and lower sides more than it by several press forming.

[0033] With the flat-surface metal mold in which the Pt-Ir alloy film of WC base material of sample No.3 was formed, also after 10000 presses, a punch becomes 9.8A, female mold becomes 9.5A, surface roughness is almost changeless press before, and it turns out that it is the metal mold which can be mass-produced. Moreover, it turned out that it is not changing at all with the condition before also pressing the surface state of such metal mold. However, with a configuration like sample No.3, since the metal mold of a diffraction grating was difficult to process it, it was not made.

[0034] On the other hand, even if the metal mold of this example of the punch of sample No.1 repeated and carried out press forming of the SF-8 glass, the surface state did not change at all and, as for change of surface roughness, after the 10000 times press was not accepted. Therefore, it turned out that the

metal mold of this example has a mold life comparable as sample No.3, and press forming of a diffraction grating can moreover be performed. That is, fertilization of a glass diffraction grating was attained by carrying out press forming of the glass plate using the press molding die of the diffraction grating obtained by the approach of this invention.

[0035] Moreover, when the configuration of 10000 glass diffraction gratings by which press forming was carried out was measured, it turned out that it is the completely same configuration as diffraction-grating original recording. Furthermore, although change of a configuration was measured after leaving the obtained diffraction grating under the environment of the temperature of 60 degrees C, and 95% of humidity for 300 hours, it turned out that it is completely changeless and excels in dependability very much.

[0036] As mentioned above, the metal mold which became possible [producing the metal mold for carrying out press forming of the glass diffraction grating by the approach of this invention], and was produced by this approach had good endurance, it was very long lasting, and it became possible [carrying out press forming of the repeat glass diffraction grating]. Furthermore, since the produced diffraction grating is glass, it has the description of it being very reliable and hardly changing also to an environment.

[0037] In addition, in order to explain this invention, the cermet which uses TiN as a principal component was used as a base material of a press molding die in the example, but even if it used for the base material the cemented carbide which uses WC as a principal component, the cermet which uses TiC as a principal component, or WC sintered compact, the same result was completely obtained. Moreover, although the Ir-Ru-Ta alloy film was used as a protective layer, even if there is thermal resistance and it uses other reactant scarce platinum group alloy film with glass, it cannot be overemphasized that the same result is obtained.

[0038] Furthermore, although the nickel-W alloy thin film was used, as long as it is the thin film which has the thermal resistance which can bear molding temperature as a thin film which copies the reversal configuration of diffraction-grating original recording, you may be what kind of thin film.

[0039] Moreover, at this example, although Si thin film was used for junction, since association of Si-O-Si is used for junction, even if it uses SiO2 thin film for junction, it cannot be overemphasized that the same metal mold is obtained.

[0040] As mentioned above, although fertilization of a glass diffraction grating with very highly precise high dependability was attained by this invention, if this invention is applied, it cannot be overemphasized until now that fertilization becomes possible by fabricating glass not only about a diffraction grating but about an optical element with the detailed configuration which was difficult to produce.

[0041]

[Effect of the Invention] As mentioned above, according to this invention, it became producible [the metal mold for detailed optical elements with the reversal configuration of detailed optical element original recording which repeats glass and can carry out press forming of it], and it became possible by carrying out press forming of the glass using this metal mold to produce in large quantities and cheaply the very reliable glass detailed optical element of the same configuration as detailed optical element original recording.

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TECHNICAL FIELD

[Industrial Application] This invention relates to a molding die required in order to manufacture the glass detailed optical element which was extremely excellent in endurance and which has a highly precise configuration by press forming.

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PRIOR ART

[Description of the Prior Art] In order to have produced the highly precise detailed optical element conventionally, the approach of processing resin directly, and the approach by shaping were adopted from the ease of the processing (for example, JP,54-110857,A, JP,60-25761,B).
[0003] However, in order that, as for such a detailed optical element made of resin, a lifting and a configuration may change [resin] a volume change with change of environments, such as temperature and humidity, it has the fault that the precision of a detailed optical element worsens. Furthermore, since the reinforcement of resin is low, there is also a fault that a blemish tends to go into a front face, and the detailed optical element with very highly precise high dependability is not obtained in the product made of resin.
[0004] On the other hand, a glass detailed optical element has good endurance, a blemish cannot go into a front face easily, and precision is not spoiled to an environmental change. Then, the method of processing glass into a detailed optical element configuration by direct dry etching is proposed as the production approach of a glass detailed optical element (for example, JP,55-57807,A).
[0005] Although the method of processing glass by dry etching can mince a detailed optical element configuration directly on a glass front face, it requires time amount for producing one detailed optical element very much, and has the fault that the thing of the same configuration is unproducible in large quantities. Therefore, by the old approach, a glass detailed optical element with very highly precise high dependability was not able to be fertilized.
[0006] On the other hand, recently, the approach of carrying out press forming of the glass is proposed as the mass-production approach of an optical-glass component (for example, aspheric surface glass lens). Image formation quality good for carrying out pressing of the highly precise optical-glass component by this approach, and manufacturing is required.
[0007] For this reason, it is required to be inactive chemically to glass, for the part used as the shaping side of glass to be hard enough, to be hard to receive the damage on an abrasion etc., and for a shaping side to cause neither plastic deformation nor grain growth with shaping in an elevated temperature, but for thermal shock resistance to be excellent also in high temperature as a metal mold ingredient, so that repeat shaping can be performed, and to excel in workability further, so that ultra-precision machining can be performed.
[0008] It considers as the metal mold ingredient with which it is satisfied of these requirements to some extent, and SiC or Si3N4 is reported (for example, JP,52-45613,A). Moreover, the metal mold which coated the platinum group alloy thin film with recently on the cemented carbide base material is also proposed (for example, JP,60-246230,A).
[0009] When SiC or Si3N4 was used for a metal mold ingredient, these ingredients were very difficult to process it into the molding die of a desired detailed optical element configuration, since the degree of hardness is very high, since each of these ingredients was rich in reactivity with glass at the elevated temperature, when repeat press forming was performed further, glass adhered to metal mold and there was a fault of it becoming impossible to fabricate a highly precise detailed optical-glass component.
[0010] Moreover, although the grinding process was possible for the metal mold which coated the

platinum group alloy thin film on the cemented carbide base material, there was a fault that a detailed configuration was not processible with high precision. Furthermore, there was a fault that processing it very with high precision took time amount very much.
[0011] Therefore, production of the molding die of a detailed optical-glass component with the sufficient endurance which repeats and carries out press forming of the glass until now, and can mass-produce a detailed optical-glass component was not completed.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, according to this invention, it became producible [the metal mold for detailed optical elements with the reversal configuration of detailed optical element original recording which repeats glass and can carry out press forming of it], and it became possible by carrying out press forming of the glass using this metal mold to produce in large quantities and cheaply the very reliable glass detailed optical element of the same configuration as detailed optical element original recording.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] If press forming of the glass is repeated and carried out and a glass detailed optical element is produced, fertilization of a detailed optical element with very highly precise high dependability is possible. For that, endurance is very good at high intensity, and the press molding die of a highly precise glass detailed optical element is required. However, by the conventional metal mold production approach, the metal mold for detailed optical elements was unproducible.
[0013] It aims at fertilizing a glass detailed optical element with very highly precise high dependability by offering the approach of producing easily the very highly precise metal mold for glass detailed optical elements with sufficient endurance which can repeat and carry out press forming of the glass in this invention, and carrying out press forming of the glass using this metal mold, in order to conquer the above fault.

[Translation done.]

MEANS

[Means for Solving the Problem] This invention offers the approach of producing easily the molding die of the glass detailed optical element which can repeat and carry out press forming of the glass, in order to solve this technical problem. Namely, a thin film is formed in the front face of the detailed optical element original recording processed with high precision beforehand. The thing in which the thin film which exfoliates in a precision and becomes the rear face of this thin film from Si or SiO2 from detailed optical element original recording about this thin film that copied the reversal configuration of a detailed optical element was formed, Although the thin film which consists of Si or SiO2 was formed in the front face of the mold base material which consists of the cermet or WC sintered compact which uses as a principal component the cemented carbide which uses WC as a principal component similarly, TiC, or TiN After giving each a hydrophilic property, both sides are joined and the approach of forming the alloy film contained at least one or more kinds in the whole mold out of Pt, Rh, Ir, Ru, Os, W, Pd, Re, and Ta as a protective layer, and manufacturing the molding die of a detailed optical-glass component is offered.

[Translation done.]

OPERATION

[Function] According to the approach of this invention, it made it possible to produce easily the molding die of the very highly precise detailed optical-glass component which can carry out press forming of the repeat glass with very sufficient endurance which was not able to be produced until now.
[0016] The metal mold of this invention moreover, by using for a mold base material the cermet or WC sintered compact which uses as a principal component the cemented carbide which uses WC as a principal component, TiC, or TiN Give only the reinforcement which is equal to press forming to the whole metal mold, and a thin film is formed in the front face of the detailed optical element original recording processed with high precision beforehand. The thing in which the thin film which exfoliates in a precision and becomes the rear face of this thin film from Si or SiO2 from detailed optical element original recording about this thin film that copied the reversal configuration of an optical element was formed, Although the thin film which consists of Si or SiO2 was similarly formed in the front face of a mold base material, after giving each a hydrophilic property, by joining both sides By being able to obtain the metal mold which has the reversal configuration of a detailed optical element easily, and forming the alloy film contained at least one or more kinds in the whole mold out of Pt, Rh, Ir, Ru, Os, W, Pd, Re, and Ta as a protective layer Even if it fabricates glass, glass does not weld to metal mold, but it can be made to carry out press forming of the repeat glass. Therefore, it becomes possible by carrying out press forming of the glass using the metal mold of this invention for repeatability to be good and to mass-produce a glass detailed optical element with the same configuration as detailed optical element original recording.

[Translation done.]

EXAMPLE

[Example] Hereafter, an example is stated to a detail. first -- as an example of a detailed optical-glass component -- press forming of a glass diffraction grating -- public funds -- the production approach of a mold is explained using a drawing.
[0018] Drawing 1 is drawing having shown the process of the production approach of the press molding die of a glass diffraction grating. The diffraction-grating original recording 11 formed aluminum (aluminum) with vacuum deposition to the disk glass substrate with a diameter [of 20mm], and a thickness of 2mm, and the pitch used what used the roux ring engine for 2 micrometers and a serrate diffraction-grating configuration with a depth of 0.5 micrometers, and was processed into the precision.
[0019] Next, as shown in drawing 1 (b), the nickel-tungsten (nickel-W) alloy thin film 12 was formed in the front face of this diffraction-grating original recording 11 by the thickness of about 15 micrometers by the sputtering method.
[0020] Thus, as shown in this drawing (c), after grinding the front face of the formed nickel-W alloy thin film 12 at a flat surface, the nickel-W alloy thin film 12 is exfoliated from the diffraction-grating original recording 11, and the reversal configuration of diffraction-grating original recording was copied to the nickel-W alloy thin film 12.
[0021] Next, as shown in this drawing (d), the Si thin film 13 was formed in the front face ground at the flat surface of this nickel-W alloy thin film 12 by the thickness of about 1 micrometer by the sputtering method. Similarly, the Si thin film 13 was formed also in the diameter of 20mm and the front face which ground the top-face part of the cermet cylinder which uses TiN with a thickness of 6mm as a principal component to the mirror plane used as a metal mold base material 14 by the thickness of about 1 micrometer by the sputtering method.
[0022] Then, as shown in this drawing (e), the hydrophilic property was given to these Si thin films 13, heat treatment was performed for both sides at lamination and 1000 degrees C for 2 hours, and the nickel-W alloy thin film 12 which copied the reversal configuration of diffraction-grating original recording was joined to the metal mold base material 14 through the Si thin film 13.
[0023] When press forming of the glass is carried out with the metal mold of this condition, the front face of a nickel-W alloy thin film oxidizes, and it becomes impossible to produce a highly precise diffraction grating. Then, as shown in this drawing (f), the iridium-ruthenium-tantalum (Ir-Ru-Ta) alloy thin film was formed in the front face as a protective layer 15 by the thickness of about 5 micrometers by the sputtering method.
[0024] The press molding die of a highly precise glass diffraction grating was able to be obtained easily as mentioned above. Thus, since the press molding die of the obtained diffraction grating copies the configuration of diffraction-grating original recording as it is, if press forming of the glass is carried out using this metal mold, a glass diffraction grating with the same highly precise configuration as diffraction-grating original recording will be obtained.
[0025] Next, press forming of the glass is carried out using the press molding die of this diffraction grating, and the example which produces a glass diffraction grating is explained using a drawing.
[0026] The schematic diagram of the press-forming machine used for drawing 2 by this example was

shown. in drawing 2 -- 21 -- the fixed block for punches, and 22 -- the heating heater for punches, and 23 -- a punch and 24 -- a glass plate and 25 -- female mold and 26 -- the heating heater for female mold, and 27 -- a plunger and 211 cover the thermocouple for female mold, and 210, a stopper and 213 cover a positioning sensor and 212, and the fixed block for female mold and 28 come out of the thermocouple for punches, and 29.

[0027] press forming of the diffraction grating produced by the above-mentioned approach -- public funds -- the mold was made into the punch 23 and the flat-surface metal mold which formed the Ir-Ru-Ta alloy thin film in the front face of the base material which ground the flat-surface part of the upper and lower sides of the cermet cylinder which uses TiN with a diameter [of 20mm] and a thickness of 6mm as a principal component to the mirror plane as a protective layer by the thickness of about 5 micrometers by the sputtering method was used for female mold 25.

[0028] The SF-8 monotonous glass 24 processed with a radius [of 10mm] and a thickness of 1mm in the shape of a disk type is placed on this female mold 25. Place a punch 23 on it, carry out a temperature up to 500 degrees C as it is, hold a pressure for 2 minutes by about 40kg/cm2 press ** by nitrogen-gas-atmosphere mind, and it cools to 400 degrees C in the condition as it is after that. The fabricated glass plate is taken out and the press-forming process of a glass diffraction grating is completed.

[0029] The above process was repeated, the up-and-down metal mold 23 and 25 was removed from the making machine at the time of the 10000th press termination, the condition of a press side was observed with the optical microscope, the surface roughness at that time (an rms value, **) was measured to coincidence, and each mold precision was evaluated to it. Since the highly precise diffraction-grating configuration shown in this example with the conventional metal mold ingredient was not processible, the monotonous metal mold which formed the Pt-Ir alloy film in the cemented carbide base material which uses as a principal component the monotonous metal mold of the SiC sintered compact currently conventionally used as comparative experiments and WC was produced, press forming was performed 10000 times similarly, and mold precision was evaluated.

[0030] The result of a press trial is shown in (Table 1).

[0031]

[Table 1]

試料 No.	金型構成	プレス前の表面粗さ（ｒｍｓ値、Å）	10000回プレス後の表面状態 表面粗さ（Å）	表面状態
1	本発明の金型	上型 9．2 下型 9．1	9．2 9．4	良好 良好
2	SiC焼結体金型	上型 12．2 下型 11．8	測定不能 測定不能	ガラス付着 ガラス付着
3	WC母材にPt-Ir を形成した型	上型 9．5 下型 9．2	9．8 9．5	良好 良好

[0032] Glass adhered to the front face and it became impossible for the flat-surface metal mold produced with the SiC sintered compact of sample No.2 to press glass for the metal mold of both upper and lower sides more than it by several press forming.

[0033] With the flat-surface metal mold in which the Pt-Ir alloy film of WC base material of sample No.3 was formed, also after 10000 presses, a punch becomes 9.8A, female mold becomes 9.5A, surface roughness is almost changeless press before, and it turns out that it is the metal mold which can be mass-

produced. Moreover, it turned out that it is not changing at all with the condition before also pressing the surface state of such metal mold. However, with a configuration like sample No.3, since the metal mold of a diffraction grating was difficult to process it, it was not made.

[0034] On the other hand, even if the metal mold of this example of the punch of sample No.1 repeated and carried out press forming of the SF-8 glass, the surface state did not change at all and, as for change of surface roughness, after the 10000 times press was not accepted. Therefore, it turned out that the metal mold of this example has a mold life comparable as sample No.3, and press forming of a diffraction grating can moreover be performed. That is, fertilization of a glass diffraction grating was attained by carrying out press forming of the glass plate using the press molding die of the diffraction grating obtained by the approach of this invention.

[0035] Moreover, when the configuration of 10000 glass diffraction gratings by which press forming was carried out was measured, it turned out that it is the completely same configuration as diffraction-grating original recording. Furthermore, although change of a configuration was measured after leaving the obtained diffraction grating under the environment of the temperature of 60 degrees C, and 95% of humidity for 300 hours, it turned out that it is completely changeless and excels in dependability very much.

[0036] As mentioned above, the metal mold which became possible [producing the metal mold for carrying out press forming of the glass diffraction grating by the approach of this invention], and was produced by this approach had good endurance, it was very long lasting, and it became possible [carrying out press forming of the repeat glass diffraction grating]. Furthermore, since the produced diffraction grating is glass, it has the description of it being very reliable and hardly changing also to an environment.

[0037] In addition, in order to explain this invention, the cermet which uses TiN as a principal component was used as a base material of a press molding die in the example, but even if it used for the base material the cemented carbide which uses WC as a principal component, the cermet which uses TiC as a principal component, or WC sintered compact, the same result was completely obtained. Moreover, although the Ir-Ru-Ta alloy film was used as a protective layer, even if there is thermal resistance and it uses other reactant scarce platinum group alloy film with glass, it cannot be overemphasized that the same result is obtained.

[0038] Furthermore, although the nickel-W alloy thin film was used, as long as it is the thin film which has the thermal resistance which can bear molding temperature as a thin film which copies the reversal configuration of diffraction-grating original recording, you may be what kind of thin film.

[0039] Moreover, at this example, although Si thin film was used for junction, since association of Si-O-Si is used for junction, even if it uses SiO2 thin film for junction, it cannot be overemphasized that the same metal mold is obtained.

[0040] As mentioned above, although fertilization of a glass diffraction grating with very highly precise high dependability was attained by this invention, if this invention is applied, it cannot be overemphasized until now that fertilization becomes possible by fabricating glass not only about a diffraction grating but about an optical element with the detailed configuration which was difficult to produce.

[Translation done.]

* NOTICES *

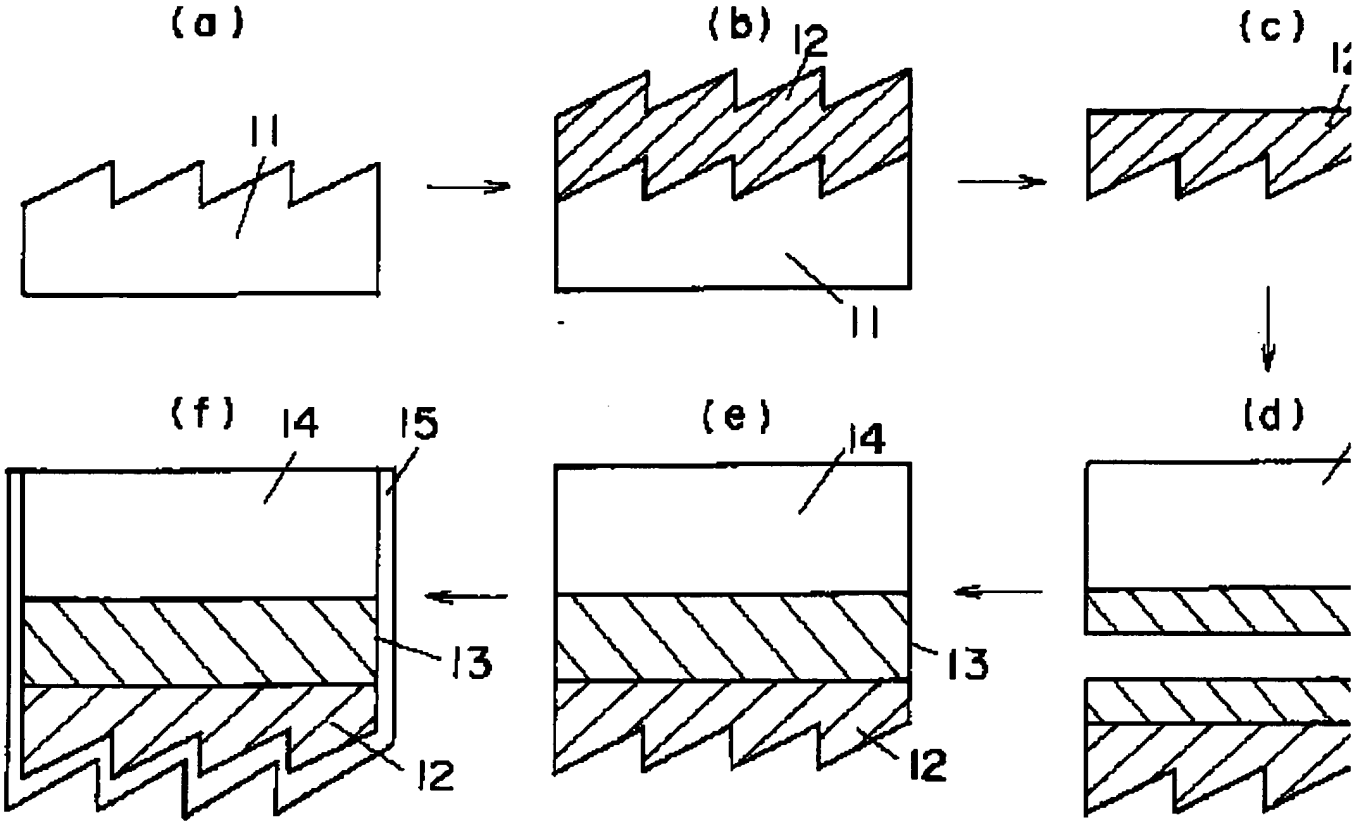
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

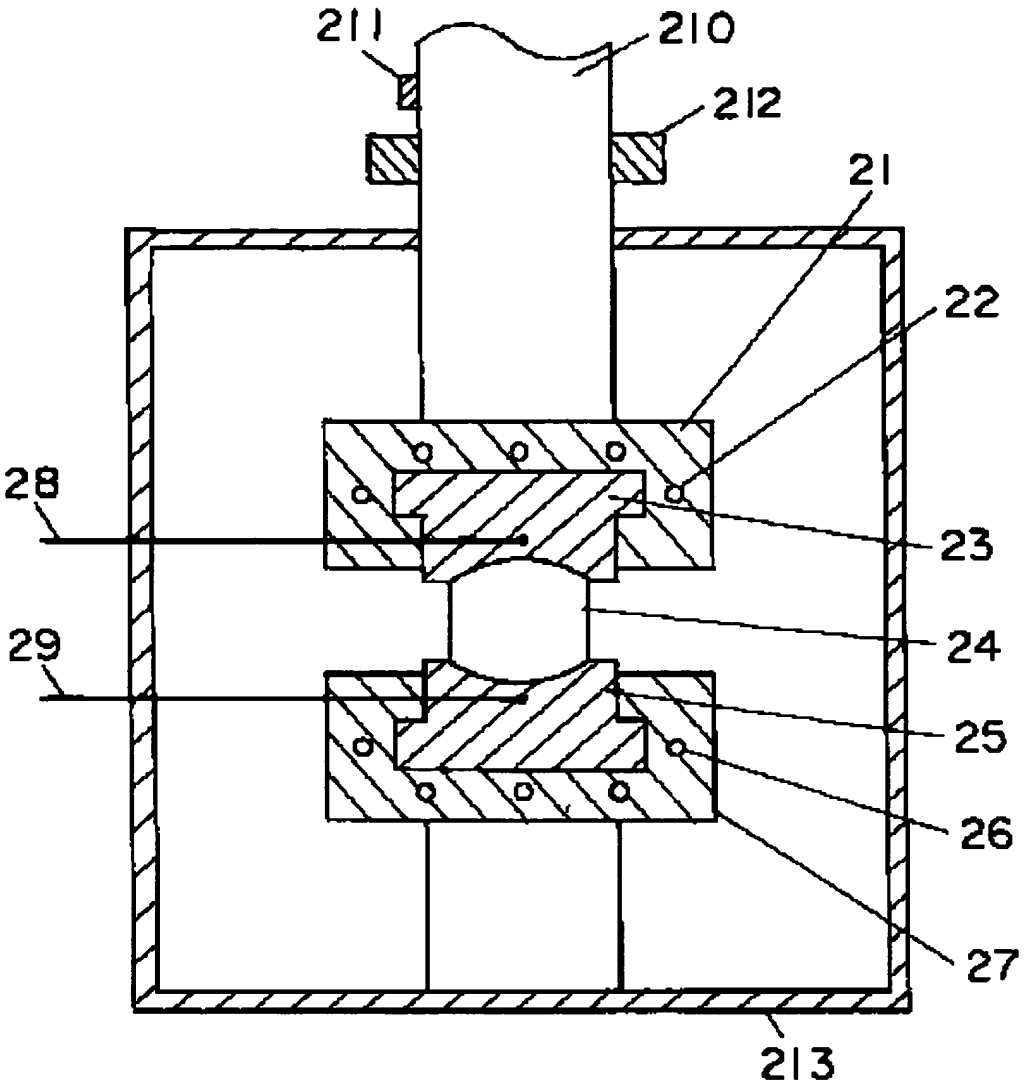
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Process drawing showing one example of the manufacture approach of the metal mold for press forming of this invention
[Drawing 2] The schematic diagram of press forming using the molding die of this invention
[Description of Notations]
11 Diffraction-Grating Original Recording
12 Nickel-W Alloy Thin Film
13 Si Thin Film
14 Metal Mold Base Material
15 Ir-Ru-Ta Alloy Protective Layer

[Translation done.]

11 回折格子原盤
12 Ni−W合金薄膜
13 Si薄膜
14 金
15 Ir−
合

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